

Trends in the Development of Innovative Processes in the Global Economy: Ukraine as an Example

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Abstract: The article confirms the relevance and importance of the development of innovative processes, which is an important factor in economic progress that benefits consumers, enterprises and the economy as a whole. The research is based on the analysis of actual material of international ratings of innovative activity, indicators of European countries, global indices, as well as scientific works of Ukrainian and foreign scientists. Based on a comprehensive approach, the place of Ukraine in the rating of innovative capacity was investigated, and the actual state of innovative activity of Ukrainian enterprises by types of economic activity was assessed. Analyzing the current trends, we found that there is a big gap between the technologies that are presented at conferences and symposiums in Ukraine, and what is implemented and used in the real sector. It was found that industry in Ukraine has always been more innovatively active than agricultural producers. The degree of implementation of advanced digital technologies in agricultural enterprises remains low today. Based on the results, the features of modern innovation processes are highlighted, as well as the problems of the development of the innovation environment are investigated. In addition, in Ukraine, several problems regarding the innovative development of the economy were revealed. As a result of the study, the authors concluded that continuous innovative development is the main direction of ensuring the growth of the national economy of Ukraine in the conditions that have developed in the state, especially in the post-war period. Some proposals have also been worked out.

Keywords: Agro-industrial complex, countries of the European Union, innovations, innovative capacity, innovation index, Ukraine.

1. INTRODUCTION

The vector of Ukraine's development is its orientation towards the economies of European states and the desire to achieve a high level of development among other states in the processes of the world economy. Undoubtedly, the innovative component is a decisive factor in realizing this task. Rapid technological growth and the ever-increasing level of global competition for both states and individual large and small companies, regardless of their industry direction, force managers and representatives of analytical services of enterprises to pay special attention to increasing the level of innovative activity. Innovative development is especially relevant for Ukraine. This is due to the need for a fundamental restructuring of the sufficiently powerful and at the same time costly and inefficient production inherited from the former USSR. Slowing down the process of innovative reorientation of the domestic economy, even under conditions of economic growth, will generate a secondary-type dependent economy in Ukraine.

Taking into account the accumulated significant practical and multifaceted theoretical experience of developing approaches to the analysis of innovative development of states, this issue is important for theoretical analysis, expanding knowledge about technological changes and innovations. Taking into account the dynamics of the main indicators of the development of the innovative economy, it is possible to highlight its main features: the openness of the economy; competitiveness at the global level; state participation; provision of high-tech services. Therefore, we believe that it will be appropriate to compare Ukraine with other European countries based on international ratings and conclusion because the assessment of the innovation potential of any region based on the constant monitoring of changes in its indicators is a necessary tool for determining the level of development of the innovative component of the regional economy and the adoption of various organizational and management decisions by local state authorities. In addition to regional public administration bodies, the obtained research results can be used by various subjects to develop their strategies.

It should be emphasized that the evaluation of innovations is essential for the development and implementation of state policy. Statistical indicators of innovation and technological

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measurements allow us to identify national strengths and weaknesses, as well as the main sources of effective innovation policy. Data on the technological capabilities and innovations of different countries provide an opportunity to gain a deeper understanding of the geographic conditions in which companies can make the necessary investments and carry out their innovative activities.

The development of scientific and technical progress is inextricably linked with the introduction of the results of scientific research into production activities. There is a direct relationship between the rate of economic growth and public spending on science. Thus, in the leading countries of the world, from 2.5 to almost 4% of the national product is spent on scientific research and development, and the contribution of scientific and technical progress (STP) to the growth of the gross domestic product of the most developed countries is 75-100%. The development of one's own scientific and technical base becomes a tool for ensuring the economic security of the state.

A significant part of the scientific works of many domestic and foreign scientists is devoted to the development of the innovative sphere. The problems of analysis and development of innovative activity are currently sufficiently developed in theoretical terms. Khakhula B.V. (2022); Pisarenko T.V., Kuranda T.K. (2017, 2022), and other scientists considered issues related to the study of the innovative sphere of Ukraine. A. I. Yakovlev in his research noted the indicators of the level of innovative development in Ukraine and provided an analysis of its components (economic, social, legislative), highlighting the problems in the field of innovative activity in Ukraine. N. M. Shmygol and O. D. Sinekaeva (2015) studied the current state and dynamics of the development of innovative activity in Ukraine according to several international indices. The authors L.D. Zapirchenko, T.F. Ryabovolyk presented an evaluation of the innovative activity of agricultural enterprises in the regions of Ukraine (2018). Also, the problem of innovation development is relevant for countries with different levels of economic development, as evidenced by the works of well-known foreign scientists, in particular, P. Makurov, D. Peterkov, K. Cherna (2020), and other authors.

So, all the above-mentioned facts determine and confirm the relevance of the research topic. However, it should be noted that the fast-moving state of the economic environment causes an urgent need for constant research into the state of innovative activity in order to develop operational solutions for innovative development.

"It is obvious the necessity of forming the minds of representatives of the agricultural sector on the importance of introducing innovative approaches, both in the production process and in the management process that cannot be done without quality equipment and skilled professionals. The urgent problem is the lack of desire of small and medium-sized agricultural producers to find opportunities to attract financial resources and use existing financial instruments" [Andrii Mykhailov, Liubov Mykhailova, Tetyana Kharchenko, Anna Shestakova, Liudmyla Mohylina, 2021].

2. METHODOLOGY

The study is based on the analysis of actual material of international ratings of innovative activity, indicators of European countries, global indices, as well as scientific works of Ukrainian and foreign scientists. The following general scientific and economic-statistical research methods were used: systematic and comparative analysis, logical generalization, systematic analysis and empirical research. With the help of the dialectical method of cognition, the peculiarities of modern innovation processes are highlighted, and the problems of the development of the innovation environment are also investigated. Based on a comprehensive approach, the place of Ukraine in the rating of innovative capacity was investigated. The actual state of innovative activity of Ukrainian enterprises by types of economic activity was assessed using economic and statistical methods.

3. RESULTS AND DISCUSSION

Innovative activity and its conditions depend on the geographic location of the economic entity. Specialized indices are calculated every year for the analysis of the global picture of innovation in different countries. Complex indicators are widely used to compare different countries with different levels of development. Innovation is a complex category that is researched at different levels: national, regional, sectoral and enterprise levels. Indices and ratings of innovative activity can be divided by level of compilation. Yes, several organizations take care of these issues on a global scale. Let's consider some of them.

Having chosen the course of European integration by Ukraine, we considered the following states for analysis according to international ratings of innovation activity, namely: Bulgaria, Latvia, Lithuania, Germany, Poland, Hungary, Ukraine, and the Czech Republic.

The study of innovation systems in the countries of the European Union and Ukraine uses data from the European Innovation Assessment System (EIS). According to this system, countries are divided into four groups of countries: innovative leaders; innovative followers; moderate innovators; catching-up countries (Innovation leader, Strong innovator, Moderate innovator, Emerging innovator). The main focus of the research is on the analysis of innovative indicators of the countries of the European Union (EU), as well as countries that are not members of the EU, such as Ukraine. In 2022, Germany made an individual rating among the countries of "strong innovators", the Czech Republic and Lithuania - "moderate innovators", and the other four countries - "catch-up" countries (see fig. 1). According to Eurostat, Bulgaria is released to a country with an equal income above the average, and Ukraine - with an equal income below the average.

Considering Ukraine's urgent desire for full membership in the European Union, it is obvious that there is a need to analyze the indicators of European countries in order to further develop a system of recommendations for improving Ukraine's innovation policy.

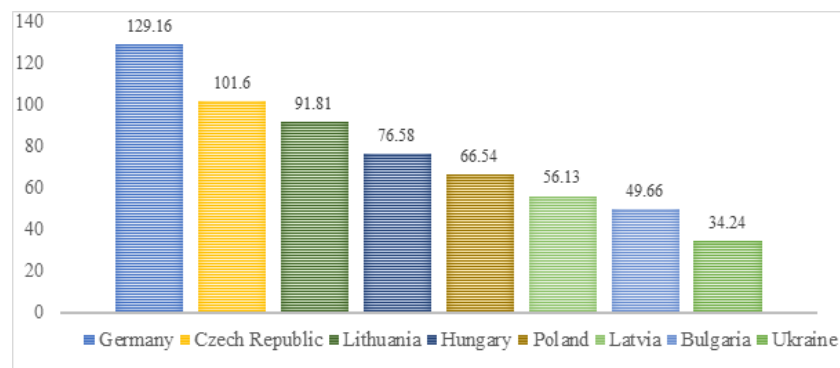


Fig. (1). Summary Innovation Index, 2022.

Source: compiled by the authors according to [European Innovation Scoreboard 2022 and Regional Innovation Scoreboard 2021].

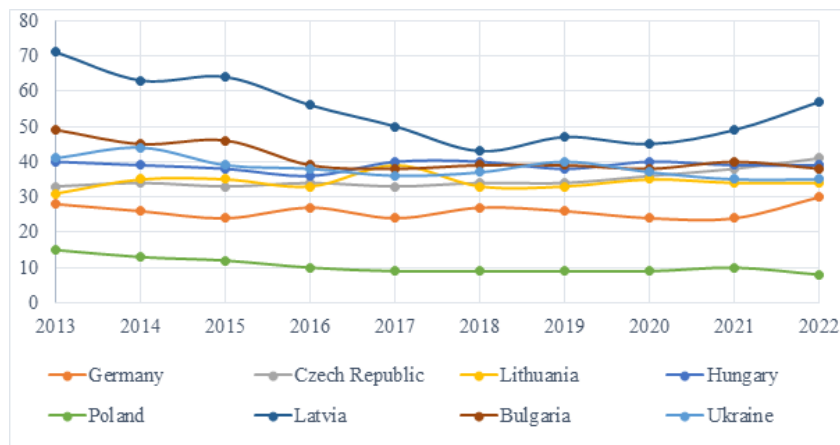


Fig. (2). Global innovation index of some countries of the world for 2013-2022.

Source: compiled by the authors according to [Global Innovation Index (GII)].

The most popular index GII (Global Innovation Index) is a study of the international business school INSEAD, Cornell University, and the World Intellectual Property Organization (WIPO) in 132 countries of the world. The purpose of the GII calculation is to evaluate and compare the aspects of innovative activity of different countries, to determine the advantages and problems of individual national economies. According to the Global Innovation Index (GII 2022), Switzerland held the leading position from 2013 to 2022. Over the past ten years, Ukraine's place in the international ranking of the Global Innovation Index has gradually shifted from 71st in 2013 to 57th in 2022 (Fig. 2). The best indicator - 43rd place - was achieved in 2018: in terms of innovation efficiency, Ukraine succeeded only by three steps behind Lithuania and four ahead of Poland.

Human capital is the main aspect of the economic development of countries. The governments of all countries pay more and more attention to its improvement because to build an effective innovation system, it is necessary to have specialists with higher education and with technical or natural areas of training. A significant role in the innovative development of the country is played by a person's life positions, behaviour patterns, and guidelines that can both influence the spread of innovations in the economy and social life, and hinder them. Therefore, experts from the Insead business school published the annual report Global Talent Competitiveness Index 2022, which shows how

effectively countries and cities attract, develop and retain talented personnel. The Portulans Institute and the Singapore Institute for Human Capital Leadership took part in its preparation. The purpose of the study is to assess the resources and efforts that countries spend on talent development, as well as the quality of human capital. The index covers 133 countries and 175 cities. The countries selected by us occupy places from 14 (Germany) to 66 (Ukraine).

The level of informatization of society acts as one of the most important indicators of the country's competitiveness since the sphere of high technologies and knowledge-intensive production is directly related to the level of development of science and informatization of society, the level of use of information and communication technologies, and therefore we considered the index of countries' readiness for a networked society (Networked Readiness Index, NRI), which is calculated annually by the international organization "World Economic Forum" together with the INSEAD business school. This indicator reflects the level of readiness of countries to use information and communication technologies for the purposes of social and economic development. Even in the Okinawa Charter of the Global Information Society in July 2000, it was emphasized that "Information and communication technologies are one of the most important factors affecting the formation of society in

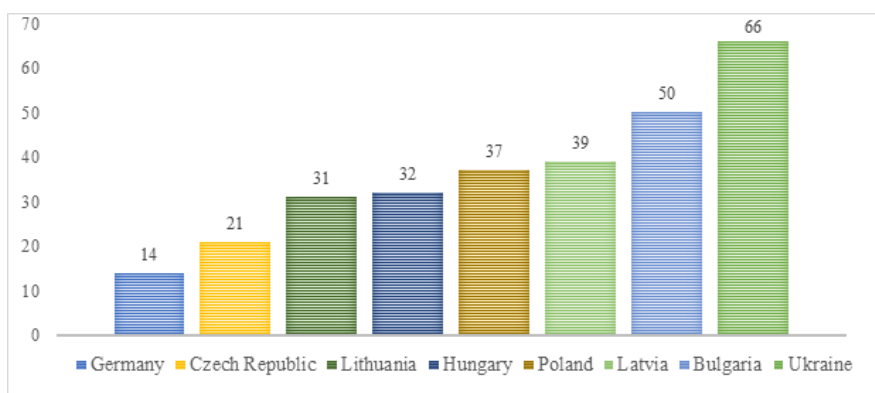


Fig. (3). Rating of some countries according to the Global Talent Competitiveness Index, 2022.

Source: compiled by the authors according to [The Global Talent Competitiveness Index 2022, p. 17-18].

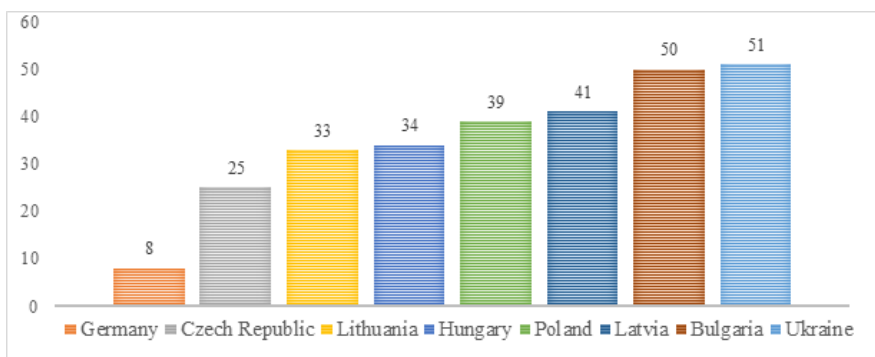


Fig. (4). The Networked Readiness Index, 2022.

Source: compiled according to [Network Readiness Index (NRI) 2022, p. 32-33].

the twenty-first century" [Okinawa Charter on Global Information Society].

The countries studied by us occupy places from 8 (Germany) to 51 (Bulgaria). Ukraine is in the 50th position, ahead of Bulgaria. If we talk about Ukraine, then in 2001 the Law of Ukraine "On priority areas of development of science and technology" No. 2623-III entered into force, where one of the priority areas is defined as information and communication technologies. Thus, in 2021, "the largest amount of expenditures of the general fund (39.1%) is directed to the implementation of scientific and technical developments under the priority direction "Information and communication technologies" [Pysarenko, T.K. Kuranda, 2022, p. 65]. The development of information technologies is a very time-consuming, long, and complex process. In 2021, 17 projects were implemented under the direction of budget funding "Projects within the scope of international scientific and technical cooperation" under the priority direction "Information and communication technologies", which accounted for 16.35% of the total number [Pysarenko, T.K. Kuranda, 2022, p. 69-70]. Therefore, information and communication technologies have become an integral part of both the modern world and the priority direction of our state. Informatization is a process that has entered all spheres of human activity to radically improve working conditions and the quality of life of the population, significantly increasing the efficiency of all types of production.

Any rating inevitably contains conventions and limitations that are characteristic of this method of organizing statistical

information, and therefore sometimes the same aspects are taken into account. Therefore, we can note that among the 8 countries selected by us, the leading positions in the 4 considered ratings are occupied by Germany, and the last places are occupied by Ukraine. Ukraine has opportunities for innovative development, but so far they remain unrealized.

We will present the dynamics of the rating of Ukraine according to four approaches to the assessment of innovative capacity for the period 2014-2022 (GII, IIV, HIKT, ZII). It allows us to conclude that there is no active policy to support innovations both on the part of the state and business. It should be emphasized that all indicators fluctuate over the years and tend to decrease. Only the Innovation Index presented by the Bloomberg agency increased by 9 points in 2021 compared to 2014. The reasons for this state are explained by the reduction of expenditures on scientific research and technological development as a percentage of GDP. Therefore, it is not for nothing that states pay great attention to the support of innovative businesses and are in many cases the initiators and locomotives of the implementation of innovative processes. At the time of the research for 2022, the Innovation Index of the Bloomberg agency has not been formed, and therefore it is not possible to present this index in the section of the state of Ukraine.

It is known that for the development of innovations, not only significant scientific and technical potential is necessary, but also there must be a demand for scientific developments. Therefore, we will analyze the processes of introducing new

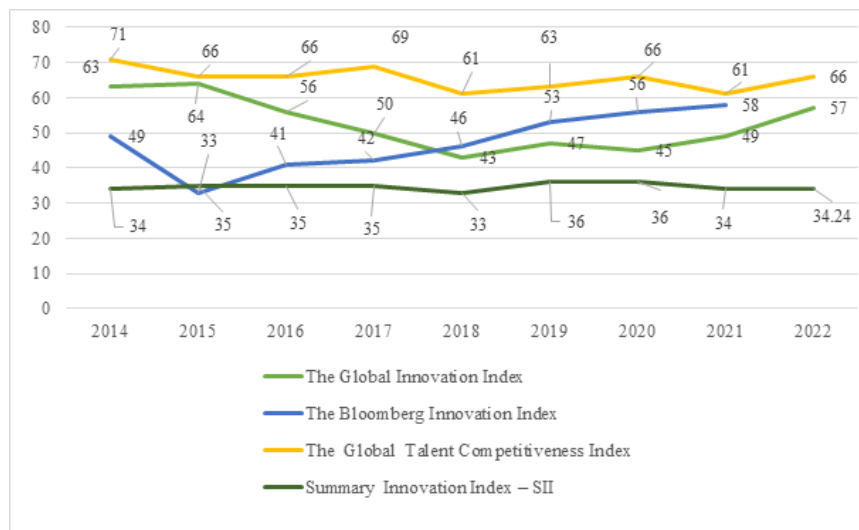


Fig. (5). Place of Ukraine according to indices of innovative capacity.

Source: compiled on the basis of data [European Innovation Scoreboard 2022 and Regional Innovation Scoreboard 2021, Global Innovation Index (GII), Pysarenko, T.K. Kuranda, 2022].

Table 1. The Number of Organizations that Carried Out Research, by Types of Economic Activity (Selected Data), Units.

| Characteristic | 2017 y. | 2018 y. | 2019 y. | 2020 y. | 2020 y. to 2017 y. (%) |
|---|---------|---------|---------|---------|------------------------|
| Total, incl. | 963 | 950 | 950 | 769 | 79,85 |
| Agriculture, forestry and fisheries | 14 | 15 | 7 | 12 | 85,71 |
| Processing industry | 40 | 46 | 19 | 17 | 42,50 |
| Professional, scientific and technical activity | 687 | 687 | 773 | 533 | 77,58 |
| Education | 152 | 146 | 134 | 160 | 106,67 |

Source: constructed by the author based on data [Naukova ta innovatsiina diialnist Ukrainy za 2019 rik, p. 14-15] and [Naukova ta innovatsiina diialnist Ukrainy za 2020 rik, p. 18-20].

ideas and scientific developments into production, i.e. directly innovative activity by types of economic activity. According to the data of the State Statistics Service of Ukraine, the number of organizations that carried out scientific research in 2017-2020 decreased by 194 organizations or by 20.15% (table 1). In 2020, the share of agricultural, forestry, and fisheries organizations in the total number of organizations was 1.56%, and the smallest was 0.74% in 2019. In the statistical collection, which was released in 2022, this indicator was not mentioned at all.

Organizations engaged in scientific and research work create new developments that can become a guarantee of success not only for the state but also for business entities. In 2021, compared to 2014, the total number of scientific and technical products created decreased by 1,482 units or by 9.64% (table 2). The share of plant varieties and animal breeds in the total amount in 2014 and 2021 was 1.38% and 0.78%, respectively. The largest number of created varieties of plants and breeds of animals was created in 2015 and amounted to 334 units, that is, 3.07% of the total number of produced scientific and technical products. This indicator was the smallest in 2019 and amounted to 108 units or 0.77% of the total number.

There is a big gap between the technologies that are presented at conferences and symposia and what is actually implemented and used in the real sector. It should be noted that the industry in Ukraine has always been more innovatively active than agricultural producers. The degree of implementation of advanced digital technologies in agricultural enterprises remains low today. The implementation of innovations is a difficult and painful process for any organization, as it is influenced by many factors, and in agriculture, several features determined by the specifics of the industry must be taken into account. The peculiarities of innovative processes in agriculture are related to the fact that agriculture affects directly (or indirectly, within the technological chain) processes, the participants of which are a person, a machine (equipment, tool, etc.), and a component of the environment (animal, plant, etc.) whose existence in the natural environment (without human intervention) is impossible or possible only with the loss of basic functional characteristics. The agrarian sector remains in an unfavourable situation, which affects, among other things, the state of the scientific and technical sphere. In the conditions of modern globalization, the Ukrainian technological level of agro-industrial production lags behind the leading world countries

Table 2. Creation of Scientific and Technical Products in Ukraine, Units.

| Type of Scientific and Technical Products | Years | | | | | | | | Ratio 2021 y. to 2014 y., % |
|---|-------|-------|-------|-------|-------|-------|-------|-------|-----------------------------|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | |
| Types of products | 496 | 636 | 417 | 495 | 712 | 927 | 689 | 638 | 128,63 |
| including equipment | 297 | 418 | 282 | 256 | 437 | 512 | 326 | 373 | 125,59 |
| Technologies | 1731 | 1062 | 880 | 751 | 760 | 764 | 549 | 509 | 29,40 |
| Materials | 490 | 436 | 457 | 561 | 468 | 594 | 344 | 511 | 104,29 |
| Varieties of plants and breeds of animals | 212 | 334 | 222 | 155 | 207 | 108 | 225 | 109 | 51,41 |
| Methods, theories | 3740 | 3689 | 4124 | 4001 | 3923 | 2838 | 2265 | 2441 | 65,27 |
| Other | 8698 | 4705 | 6325 | 10868 | 8372 | 8780 | 9858 | 9677 | 111,26 |
| Total | 15367 | 10862 | 12425 | 16831 | 14442 | 14011 | 13930 | 13885 | 90,36 |

Source: constructed by the author based on data [Analitichna dovidka 2015, 2016, 2017, 2018, 2019, 2020, 2021, Pysarenko, Kuranda, 2022].

Table 3. Implementation of Scientific and Technical Products by Priority Directions in Ukraine, %.

| Type of Scientific and Technical Products | Years | | | | | | | | Ratio 2021 y. to 2014 y., (+, -) |
|---|-------|------|------|------|------|------|------|------|----------------------------------|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | |
| Types of products | 54,6 | 42,7 | 38,6 | 31,7 | 39,8 | 28,4 | 22,3 | 30,4 | -24,2 |
| including equipment | 53,8 | 46,2 | 45,3 | 46,5 | 49,0 | 39,7 | 32,6 | 33,2 | -20,6 |
| Technologies | 44,3 | 54,5 | 67,0 | 51,5 | 73,2 | 73,8 | 51,7 | 53,9 | 9,6 |
| Materials | 38,9 | 23,2 | 25,1 | 35,3 | 58,0 | 34,8 | 29,9 | 21,7 | -17,2 |
| Varieties of plants and breeds of animals | 22,2 | 9,6 | 56,3 | 29,0 | 37,7 | 59,2 | 15,1 | 25,7 | 3,5 |
| Methods, theories | 63,9 | 51,3 | 54,7 | 60,9 | 72,8 | 71,9 | 50,8 | 46,5 | -17,4 |
| Other | 68,5 | 40,3 | 68,2 | 61,6 | 74,5 | 68,2 | 56,3 | 54,5 | -14,0 |
| Total | 62,3 | 44,3 | 60,2 | 58,8 | 71,1 | 66,0 | 52,1 | 50,2 | -12,1 |

Source: constructed by the author based on data [Analitichna dovidka 2015, 2016, 2017, 2018, 2019, 2020, 2021, Pysarenko, Kuranda, 2022].

Analyzing the data on the introduction of scientific and technical products according to priority areas in Ukraine, which are presented in table 3, we can conclude that during the studied period, all types of scientific and technical products that were introduced in Ukraine had a tendency to decrease, except for two types - technology; varieties of plants and breeds of animals. It should be noted that the rate of introduction of plant varieties and animal breeds fluctuated over the years. This indicator was the highest in 2019 at the level of 59.2%, and the lowest in 2015 – 9.6%.

Khakhula B.V., having conducted research, notes that "traditionally, new or improved technologies for the production of agricultural products are in the first place among innovations. In the second and third places are new varieties and hybrids of agricultural crops, as well as new crosses of poultry, lines, and breeds of animals. Then – deep processing of products and introduction of new techniques, mechanisms, and equipment" [Khakhula, B. V., 2022, p. 82]. Zapirchenko L. D., Ryabovolyk T. F. claim in their research

that "agrarian enterprises transfer innovations into everyday work at a low rate" [Zapirchenko, L. D., Ryabovolyk, T. F., 2018, p. 82]. "The most important factor limiting the innovative activity of an agricultural enterprise, according to the respondents, as expected, is the insufficient level of provision of own financial resources (40.8%)" [Khakhula, B. V., 2022, p. 87].

To characterize the processes of commercialization of innovations, we will use statistics on developed and used advanced production technologies in agriculture. In 2019, according to the results of the evaluation of the Innovativeness Index of Ukrainian companies by Mind, only one enterprise of the agro-industrial complex overcame the barrier of 75 points and received the status of innovative (table 4). This is the "Agroprosperis" group of companies, which, according to the rating of the top 100 latifundists of Ukraine in 2022 presented on the Latifundist.com website, ranks 4th and cultivates 300,000 hectares [Top 100 latyfundystiv Ukrainy]. Agro-industrial holding "MHP" occupies

Table 4. Innovation Index 2019 from Mind (Agro-Industrial Complex).

| № | Name of Company | Total Index Indicator, Points | Innovativeness of the product | Innovativeness of business processes | Innovativeness of the business model | Innovations in work with clients | Readiness for changes |
|---|-----------------|-------------------------------|-------------------------------|--------------------------------------|--------------------------------------|----------------------------------|-----------------------|
| 1 | Agroprosperis | 78 | 66 | 87 | 75 | 80 | 88 |
| 2 | MHP | 70 | 70 | 77 | 51 | 75 | 77 |
| 3 | Astarta | 66 | 60 | 76 | 55 | 65 | 78 |
| 4 | Kernel | 62 | 51 | 78 | 55 | 61 | 69 |
| 5 | Ukrlandfarming | 46 | 45 | 59 | 38 | 50 | 37 |

Source: according to data [Innovation Index 2019].

the third position in the rating. Cultivating 370,000 hectares, the company began its work on the Ukrainian agricultural market in 1998. Now it is the largest producer of poultry meat in Southeast Europe. The company "Astarta" occupies the 5th position (220 thousand hectares under cultivation). The first step of the rating is headed by the Kernel company, which in 2022 cultivated 506 thousand hectares of land. Agroholding "Ukrlandfarming" is the second, cultivating 460,000 hectares. The agricultural holdings presented in Table 1 are the largest in Ukraine, as they are in the top five of the rating.

In 2020, the rating of the Index of Innovativeness of Companies (Mind Innovation Index 2020) was again conducted [Opytuvalnyk predstavnykiv biznesu shchodo innovatsiinoi diialnosti ta aktualnykh potreb v R&D, 2020, p. 14-15]. Among all Ukrainian companies that took part in the survey, the highest innovation index was 46. Agricultural enterprises scored only 27 points. These enterprises were recognized as those that "partially implement innovations or actively apply the achievements of global players in the local market" [Opytuvalnyk predstavnykiv biznesu shchodo innovatsiinoi diialnosti ta aktualnykh potreb v R&D, 2020, p. 18]. A characteristic trend of recent years, despite economic instability, is the gradual launch of innovative processes. This especially applies to the group of the most advanced farms in the agrarian sphere or those that are intensively engaged in the introduction of innovations in production. At the same time, the vast majority of enterprises that implement the achievements of science in production achieve a significant improvement in production and economic indicators. This is especially evident in the increase in yield and productivity of animal husbandry. The content of the innovations covered in the main branches and spheres of agro-industrial production differ significantly. This is naturally related to their branch, functional, technical and technological and organizational characteristics. Therefore, in order to compete with other companies, managers of agricultural holdings must effectively manage innovation processes. They are forced to make decisions that can affect the efficiency and productivity of enterprises. Only one out of five large agricultural holdings received the

status of innovative. Others do not reach it. There is an axiom that in order to run a successful business, it is necessary to introduce innovations into production and to be able to manage the innovation process at the enterprise. There are more than enough innovative technologies, but only a part of farmers use them in their work due to financial constraints, and therefore it is necessary to always be "in tune" and have information about the latest innovative achievements. And an important role is played by the innovative management of agricultural enterprises.

The appearance of new major players in the agricultural market contributes to the acceleration of innovation processes in the agricultural sector and changes in personnel policy. In contrast to cautious managers of smaller enterprises, representatives of big businesses boldly take risks, introducing new technologies, updating the seed fund and livestock breeds, and diversifying production. But the share of large businesses with sufficient financial resources in the total volume of agricultural producers is small. The main sources of funding for innovative projects are expensive bank loans, as well as financial support from regional administrations.

Let us emphasize that in a rather conservative agricultural market, the future of large agricultural holdings lies in the creation of product preservation, logistics, and supply processes for small farmers. When working on the ground, they are more effective because they can respond to situations locally and depend on bureaucratic processes. Therefore, some agricultural holdings work with farmers through a supply chain that provides the farmer with everything he needs: seeds, pesticides, fertilizers, loans, elevator services, rail car services, and farmer export contracts. Only few countries in the world have such large agricultural holdings as Ukraine. Therefore, agricultural holdings should be the first to undergo this transformation.

In 2021, Mind together with the Reactor.ua platform prepared the first Disrupt Innovation Index in Ukraine - a study of companies' readiness to face changes in their market due to the impact of innovations (table 5). At the forefront of digital innovation transformation are 5 large agricultural

Table 5. Innovative Activity of the Main Agrarian Leaders According to the Disrupt Innovation Index 2021.

| № | Company Name | Revenue, 2020 | Key Innovations |
|---|---|---|--|
| 1 | Agro-industrial holding "Myronivskyi Hlibo-product" | 53,4 billion of UAH (including 35,97 billion of UAH for PJSC "MHP", 10,2 billion of UAH for "Myronivska PF", 4,3 billion of UAH for "Zernoproduct MHP" PJSC). | changing the vector of the company's development from raw materials to culinary; creation of a specialized Department of Innovations of the MHP, which develops, tests and scales investment projects; investments in new businesses, such as retail and cloud kitchens; upgrade of employees' competencies. |
| 2 | "Kernel" | 83 billion of UAH (including Kernel Trade LLC 67,4 billion of UAH, Druzhba-Nova LLC 5 billion of UAH, ENSELCO AGRO LLC 3,5 billion of UAH) | digitization of processes; precision agriculture, including UAVs, satellite images of fields; Big Data technologists; Real-time Analytics; Machine Learning. |
| 3 | "AB InBev Efes Ukraine" | 6,7 billion of UAH | digitization, elements of AI, automation and Big Data, B2B platform "VyBEERay", eco-optimization of production, transition to a new preform and reduction of bottle weight. |
| 4 | "Astarte" | 14,7 billion of UAH (including "Zerno-Agro trade" LLC 4,03 billion of UAH, "Tsukoragroprom" LLC 4 billion of UAH, "Globinsky Processing Plant" LLC 2,4 billion of UAH). | AgriChain concept, energy efficiency projects, bioenergy, optimization of equipment park, precision agriculture. |
| 5 | Syngenta | 9,99 billion of UAH | investments in the launch of new products with minimal impact on the soil; reduction of the residual content of hazardous substances in agricultural products and the environment; investments in reducing carbon emissions; launch of Digital Innovation Lab; 3D "fields of innovation". |

Source: based on data [Mind Disrupt Innovation Index 2021].

enterprises, their main innovations are named. Let us emphasize that the key problem of Ukrainian farmers is that at least some technologies become available only to large and medium-sized businesses. So far, not all enterprises, let alone farmers, can use advanced solutions. However, digitalization tools will become cheaper, and cloud technologies are designed to make their use widespread. During the season, the agricultural producer has to make more than 40 different decisions: which seeds to plant, when to plant, how to process them, what to treat, and so on. The lack of information for decision-making leads to the fact that up to 25-40% of the harvest is lost in the process of planting, growing, and caring for crops. 2/3 of the loss factors today can be controlled by automated control systems.

In our opinion, the following innovations that can be implemented in various fields of agriculture in the short and medium term can be considered the most potentially effective today, namely: safe genetic engineering of seed material; zero flow hydrosystem fishing; tray-condensate irrigation systems; "sea" potatoes; computer management of cattle; bioinsecticides and pollinators; cocoon-sleeve granaries; precision seeding technologies; "smart" greenhouses; Craft Scanner sensors for monitoring the depth of tillage; aeroponic farms (growing plants without soil); use of drones; precision farming systems; use of cloud technologies; digitization of accounting (collection, transfer, analysis and processing of data); modernization of equipment and others. Digital technological changes also significantly affect the economic development of agricultural enterprises. Today, there is already agricultural machinery with fuel level sensors, cruise control, autopilot, remote monitoring systems, autopilot systems, and artificial vision

technology. In the agricultural sector, financial investments by digital IT companies and investors are intensively made.

The transition of the industry to the digitalization of business processes will take time: peasant farms operating in the old way are competitive due to cheap labour. In this regard, it is necessary to ensure an acceptable level of penetration of the Internet and IT technologies in Ukrainian villages, as required by the integration of the agricultural sector in modern competitive conditions. New innovative technologies are a challenge not only for agricultural producers themselves but also for Ukrainian startups involved in the development of innovations. Jindra Peterkova, Katarzyna Cherna, and Pavla Makurova conducted an interesting study on the implementation of innovations at enterprises in the Czech Republic and Poland. They determined that during their implementation there is a significant influence of "management as the initiator of innovative activity in 56% of cases, not the owner" [Jindra Peterková, Katarzyna Czerná, Pavla Macurová, 2020, p. 4]. The same trend is observed in Ukraine.

The implementation of modern digital technologies in the practical activities of agricultural producers is the main driver of progress in the agricultural sector, where, unlike other sectors of the economy, the introduction and spread of innovations and innovative technologies is slower, which requires special attention and significant state support. The implementation of innovations by agricultural enterprises is limited by such factors as: low solvency, lack of long-term investments in innovative agricultural technologies, and lack of reliable and comprehensive information about new scientific developments. Thus, in modern conditions, the development and implementation of technological

innovations were carried out by only 4.8% of the total number of agricultural enterprises, which is due to the reduction of the volume of investment programs, including innovative activities, and the structural restructuring of agriculture. The state innovation policy in the agricultural sector is not properly implemented, and producers are forced to decide on the practical application of innovations on their own.

The management process is most often positively advanced by making appropriate decisions regarding the maximum involvement of available innovation resources, as well as the formation of infrastructure to ensure innovation processes. The implementation of any innovative project requires the expenditure of certain resources, the cost and effectiveness of which must be assessed. The basis of the project approach to the investment activity of the agrarian sphere is the principle of estimating cash flows. Its feature is its predictive and long-term nature, which makes it necessary to take into account time and risk factors. The main thing is that the result of any innovative project is profit (income). All project participants should benefit from its implementation. Thus, by using and implementing innovative developments, agricultural enterprises will reduce costs, increase production volumes and profits, and conquer sales markets, which will contribute to increasing economic efficiency and the development of the national economy of Ukraine.

However, in the conditions of the war in Ukraine, there are a number of problems regarding the innovative development of the economy, which are caused by:

- the lack of sustainable economic development in the conditions of hostilities;
- the presence of a deep economic crisis;
- the destruction of economic chains between enterprises and sectors of the economy;
- many enterprises are on the brink of bankruptcy;
- lack of investments due to negative macroeconomic indicators and forecasts;
- an unstable macroeconomic environment, which limits the possibilities of valuable investments in innovative projects, the payback of which takes time;
- increasing losses of intellectual potential due to migration, etc.

The Ministry of Economy of Ukraine, using indirect calculation methods and modelling tools based on behavioural indicators of economic entities, estimated the drop in GDP at the end of 2022 at the level of 30.4% [$\pm 2\%$] (an increase of 3.4% in 2021). This is objectively the worst result since independence, but better than most experts expected at the beginning of the full-scale invasion, when estimates ranged from a 40-50% drop in GDP and more Ministry of Economy of Ukraine. The Ministry of Economy preliminarily estimates the drop in Ukraine's GDP in 2022 at 30.4%.

As we can see, in the innovative sphere of economic development of Ukraine there are many "pitfalls" that hinder the development of the industry. However, even despite this, our state has high resources, which with proper regulation

can ensure a radically new development of the innovative economy, which we see as a basis for further research on the formulation of prospects for the innovative development of Ukraine.

Therefore, taking into account everything stated, we believe that continuous innovative development is the main direction of ensuring the growth of the national economy of Ukraine in the conditions that have developed in the state and especially in the post-war period. Therefore, among the main measures to strengthen the innovative activity of the state, we will define:

- implementation of an effective state policy aimed at priority scientific and technological development of the economy;
- the creation of an effective system of state management of innovations, which is based on the priorities approved by the President of Ukraine following the available natural and human resources and the geopolitical situation and geographical location of Ukraine;
- promoting the process of effective interaction between the sphere of work and the sphere of education;
- completion of the formation of a single legislative field of innovative activity;
- improvement of the tax system of Ukraine;
- significant improvement of the national system of protection and management of intellectual property, which is still a weak link for innovative development of the state;
- a set of measures aimed at increasing the competitiveness of national science and education.

It is possible to name several other important component models of innovative development of the state. But all of them work only under the condition of consolidation of the country around priority, high-tech development of society.

4. CONCLUSIONS

High intellectual potential and high-tech developments in the field of agriculture are the basis for the development of innovative activities of all business entities. The domestic experience of using the results of scientific research by agricultural producers shows that the modern trend of developing innovative methods in agriculture is contradictory. On the one hand, in recent years, despite serious economic difficulties, agricultural science has been successfully functioning, producing a significant amount of high-quality scientific products and creating advanced farms, overcoming the negative situation (mainly external) and developing innovative activities. However, unfortunately, this does not apply to the agro-industrial complex. The current economic situation, a sharp decrease in the solvent demand for scientific and technical and science-intensive products led to the appearance of a reverse trend and a delay in the development of the innovation process. Instead of technical and technological modernization and improvement of production based on the development of innovations, in some regions, there is a forced return to imperfect methods and technologies, which is an actual departure from the process of creating high-tech production as an important

direction in the development of agriculture and other sectors of the world, which means complex agro-industrial.

In general, innovations in the agriculture of our country can be divided into several groups. First, these are innovations related to the wear and tear or strong moral obsolescence of agricultural machinery. Although these investments may seem devoid of an innovative component, the situation in a significant part of the country's agrarian farms is exactly this. Therefore, the introduction of technology that is widely used in Western countries can be considered a "regional" innovation in our country. Secondly, the innovation will be the introduction of elite varieties of plants, as well as highly productive breeds into production. Thirdly, innovations can be in the application of scientific developments to stimulate production, that is, new fertilizers and additives in various areas of agriculture. Fourth, innovation can affect the management system of the enterprise - from new management approaches to the introduction of electronic control and production management systems. Fifthly, innovations may relate to infrastructure, which is related to macroeconomic decisions and requires attention and support from the state. This includes measures to assess the state of the soil and recommendations to farmers, consultations on the introduction of certain innovations in production, and informing about various developments and opportunities. Perhaps these will be programs for renting high-performance agricultural machinery from the state. The gradual and measured application of all these types of innovation in practice can have a positive effect on the agricultural sector.

We can conclude that the current state of the agricultural sector does not correspond to the fact that the sectoral scientific, technical, and innovation policy of Ukraine is implemented properly. Without effective state support, agricultural producers often have to independently solve all the problems associated with the practical application of the latest scientific achievements.

So, the main task of the state should be to actively carry out reforms and modernize all spheres of the economy by creating favorable conditions for the successful conduct of business and entrepreneurship in accordance with European standards, a significant improvement of the institutional structures of state regulation, bringing them closer to the principles of EU law [Turchina S.G., Dashutina L.O., Nechyporenko V.V., 2019].

REFERENCES

- Analitichna dovidka "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniky ta otrymani rezultaty u 2020 r.". (Electronic resource) (2021)/ pidhotovlena avtorskym kolektyvom Derzhavnoi naukovoï ustanovy "Ukrainskyi instytut naukovo-tekhnichnoi ekspertyzy ta informatsii" Ministerstva osvity i nauky Ukrainy. Kyiv. 58 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/2021/06/16/AD.Nauk.priorytety.2020.pdf> (in Ukrainian).
- Analitichna dovidka "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniky ta otrymani rezultaty u 2019 r.". (Electronic resource) (2020) / pidhotovlena avtorskym kolektyvom Derzhavnoi naukovoï ustanovy "Ukrainskyi instytut naukovo-tekhnichnoi ekspertyzy ta informatsii" Ministerstva osvity i nauky Ukrainy. Kyiv. 60 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/2020/06/realizatsiya-priorytetiv-nauki-i-tekhniki-u-2019-r150620.pdf> (in Ukrainian).
- Analitichna dovidka "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniky ta otrymani rezultaty u 2018 r.". (Electronic resource) (2019) / pidhotovlena avtorskym kolektyvom Derzhavnoi naukovoï ustanovy "Ukrainskyi instytut naukovo-tekhnichnoi ekspertyzy ta informatsii" Ministerstva osvity i nauky Ukrainy. Kyiv. 58 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/vru2018.pdf> (in Ukrainian).
- Analitichna dovidka "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniky ta otrymani rezultaty u 2017 r.". (Electronic resource) (2018) / pidhotovlena avtorskym kolektyvom Derzhavnoi naukovoï ustanovy "Ukrainskyi instytut naukovo-tekhnichnoi ekspertyzy ta informatsii" Ministerstva osvity i nauky Ukrainy. Kyiv. 52 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/dovidka-realizatsiya-priorytetnykh-napriamiv-rozvytku-nauki-i-tekhniki-ta-otrimani-rezultaty-u-2017-r.pdf> (in Ukrainian).
- Analitichna dovidka "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniky ta otrymani rezultaty u 2016 r.". (Electronic resource) (2017) / pidhotovlena avtorskym kolektyvom Derzhavnoi naukovoï ustanovy "Ukrainskyi instytut naukovo-tekhnichnoi ekspertyzy ta informatsii" Ministerstva osvity i nauky Ukrainy. Kyiv. 52 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/ad-vru-2017-prav-1.pdf> (in Ukrainian).
- Analitichna dovidka "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniky ta otrymani rezultaty u 2015 r.". (Electronic resource) (2016)/ pidhotovlena avtorskym kolektyvom Derzhavnoi naukovoï ustanovy "Ukrainskyi instytut naukovo-tekhnichnoi ekspertyzy ta informatsii" Ministerstva osvity i nauky Ukrainy. Kyiv. 51 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/ad-vru-1.pdf> (in Ukrainian).
- Analitichna dovidka "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniky ta otrymani rezultaty u 2014 r.". (Electronic resource) (2015) / pidhotovlena avtorskym kolektyvom Derzhavnoi naukovoï ustanovy "Ukrainskyi instytut naukovo-tekhnichnoi ekspertyzy ta informatsii" Ministerstva osvity i nauky Ukrainy. Kyiv. 51 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/realizatsiya-priorytetiv-u-2014-roczni.pdf> (in Ukrainian).
- Analysis Explore economy briefs from the GII 2022. *Global Innovation Index*. <https://www.globalinnovationindex.org/analysis-economy>
- Andrii Mykhailov, Liubov Mykhailova, Tetyana Kharchenko, Anna Shestakova, Liudmyla Mohylina (2021), Investment Instruments for Managing Innovative Transformations of the Agricultural Sector to Ensure Sustainable Development in the Context of Globalization. *Estudios de Economía Aplicada*. Vol. 39. No 7: Special Issue: Impact of Current Trends in Social Commerce, Economics, and Business Analytics. P. 1-14 URL: <http://ojs.ual.es/ojs/index.php/eea/article/view/5068> (in Ukrainian).
- European Innovation Scoreboard 2022 and Regional Innovation Scoreboard 2021. *An official website of the European Union*. <https://ec.europa.eu/research-and-innovation/en/statistics/performance-indicators/european-innovation-scoreboard/eis>
- Global Innovation Index (GII). *WIPO*. https://www.wipo.int/global_innovation_index/en/
- Innovation Index 2019. *Reactor.ua. Platforma vidkrytykh innovatsii supported by mind.ua*. <https://mind.ua/innovativeteams/index> (in Ukrainian).
- Jindra Peterková, Katarzyna Czerná, Pavla Macurová (2020), "Evaluation of innovation activities and innovation management model of selected innovative companies". *SHS Web of Conferences* 74, 02014. https://www.shs-conferences.org/articles/shsconf/pdf/2020/02/shsconf_glob2020_02014.pdf
- Khakhula, B. V. (2022), "Innovatsii, yak chynnyk pryskorennia naukovo-tekhnichnoho prohresu v aharnomu sektori Ukrainy" ["Innovation as an accelerating factor of scientific and technical progress in the agricultural sector of Ukraine"]. *Ahrosvit*. Vol. 9-10, pp. 79-85. doi:10.32702/2306-6792.2022.9-10.79 (in Ukrainian).
- Khakhula, B. V. (2022), "Orhanizatsiini osoblyvosti rozvytku innovatsiinoi diialnosti v silskohospodarskomu vyrobnytstvi" ["Organizational features of innovative activity development in agricultural production"]. *Ekonomika ta derzhava*. Vol. 5, pp. 85-89. doi: 10.32702/2306-6806.2022.5.85 (in Ukrainian).

- Mind Disrupt Innovation Index 2021: yaki kompanii ukrainskoho APK hotovi staty innovatsiinymy. *Reactor.ua. Platforma vidkrytykh innovatsii supported by mind.ua*. <https://mind.ua/publications/20234607-mind-disrupt-innovation-index-2021-yaki-kompaniyi-ukrayinskogo-apk-gotovi-stati-innovacijnimi> (in Ukrainian).
- Naukova ta innovatsiina diialnist Ukrainy za 2019 rik: statystychnyi zbirnyk. (Electronic resource) (2020) / vidp. za vypusk Kuznietsova M. S. Kyiv: Derzhavna sluzhba statystyky Ukrainy. 99 p. https://ukrstat.gov.ua/druk/publicat/kat_u/2020/zb/09/zb_nauka_2019.pdf (in Ukrainian).
- Naukova ta innovatsiina diialnist Ukrainy za 2020 rik: statystychnyi zbirnyk. (Electronic resource) (2021) / za red. M. Kuznietsovoi. Kyiv: Derzhavna sluzhba statystyky Ukrainy. 243 p. https://ukrstat.gov.ua/druk/publicat/kat_u/2021/zb/10/zb_Nauka_2020.pdf (in Ukrainian).
- "Naukova ta naukovo-tekhniczna diialnist v Ukraini u 2021 rotsi: naukovo-analitychna dopovid" (Electronic resource) (2022)/ T.V. Pysarenko, T.K. Kuranda ta in. – K.: UkrINTEI. 93 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/2022/09/09/Nauk-analitychn.dop.Naukova.ta.nauk-tekh.n.diyal.v.Ukrayini.2021-09.09.2022.pdf> (in Ukrainian)
- Network Readiness Index (NRI) 2022 <https://networkreadinessindex.org/>
- Okinawa Charter on Global Information Societ. *Ministry of Foreign Affairs of Japan*. https://www.mofa.go.jp/policy/economy/summit/2000/documents/c_harter.html
- Opytuvalnyk predstavnykiv biznesu shchodo innovatsiinoy diialnosti ta aktualnykh potreb v R&D. Finalnyi zvit (Electronic resource) (2020). Ministerstvo osvity i nauky, Ministerstvo rozvytku ekonomiky, torhivli ta silskoho hospodarstva Ukrainy, Ministerstvo tsyfrovoi transformatsii Ukrainy. <https://mon.gov.ua/storage/app/media/innovatsii-transfer-tehnologiy/2020/08/28.08/opituvannya-28-08-2020.pdf> (in Ukrainian).
- "Realizatsiia priorytetnykh napriamiv rozvytku nauky i tekhniki ta otrymani rezultaty u 2021 r.: analitychna dovidka" (Electronic resource) (2022) / T.V. Pysarenko, T.K. Kuranda ta in. K.: UkrINTEI, 53 p. <https://mon.gov.ua/storage/app/media/nauka/informatsiyno-analitychni/2022/07/27/Analych.dov.Real.priorytet.napr.rozv.nauky.tekhniki.2021-08.08.2022.pdf> (in Ukrainian).
- The Global Talent Competitiveness Index 2022. The Tectonics of Talent: Is the World Drifting Towards Increased Talent Inequalities? / Bruno Lanvin and Felipe Monteiro, Editors. 336 p. <https://www.insead.edu/sites/default/files/assets/dept/fr/gtci/GTCI-2022-report.pdf>.
- Top 100 latyfundystiv Ukrainy. *Latifundist.com. Holovnyi sait pro ahrobiznes*. <https://latifundist.com/rating/top100#325>. (in Ukrainian).
- Turchina S.G., Dashutina L.O., Nechyporenko V.V., 2019. Development of foreign economic communities of Ukraine in the context of globalization and euro-integration processes. *Revista Espacios*, Caracas, Venezuela. Vol. 40 (Number 30). Page 19. <https://www.revistaespacios.com/a19v40n30/19403019.html>
- Zapirchenko, L. D., Riabovolyk, T. F. (2018), "Osoblyvosti innovatsiinoy diialnosti ta vprovadzhenia innovatsii u vyrobnychu diialnist ahrarykh pidpryemstv" ["The Features of Innovative Activity and Implementation the Innovations to the Production Activities of Agrarian Enterprises"]. *Tsentrlnoukrainskyi naukovyi visnyk. Ekonomichni nauky*. Issue 1 (34), pp. 200-210. doi: [https://doi.org/10.32515/2663-1636.2018.1\(34\).259-268](https://doi.org/10.32515/2663-1636.2018.1(34).259-268) (in Ukrainian).
- Pisarenko T.V., Kuranda T.K., Yevtushenko V.M., Kochetkova O.P. (2017), "Status of scientific and scientific and technical activities in Ukraine under monitoring data" ["Status of scientific and scientific and technical activities in Ukraine under monitoring data"]. *Science, technology, innovation*. No. 3 (3). P. 12-22. http://nti.ukrintei.ua/wp-content/uploads/2018/05/2017-3_stat2_UA_povn.pdf (in Ukrainian).
- Musina, L., Pisarenko, T. Kvasha, T. (2022), «TRANSFORMATSIYNA INNOVATSIYNA POLITYKA: YEVIROPEYS'KA PERSPEKTYVA DLYA UKRAYINY» ["TRANSFORMATIONAL INNOVATION POLICY: A EUROPEAN PERSPECTIVE FOR UKRAINE"], *InterConf*. (105), p. 174-186. doi: 10.51582/interconf.19-20.04.2022.016. (in Ukrainian).
- Shmygol N. M., Sinekaeva O. D., (2015). Analiz ta otsinka innovatsiynoy diyal'nosti na mashynobudivnykh pidpryemstvakh [Analysis and assessment of innovative activity at machine-building enterprises]. *Bulletin of Zaporizhzhya National University*. No. 1 (25). P. 41–48. http://nbuv.gov.ua/UJRN/Vznu_eco_2015_1_8 (in Ukrainian).

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